

Reconstruction of an Oligocene lacustrine ecosystem from Enspel, Germany using C and N stable isotopes

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The Late Oligocene (25.8 Ma) Enspel Fossilagerstätte in Westerwald, Germany, contains a comprehensive fossil ecosystem including plant compressions, beetles with original chitin, and vertebrates preserved by lithified bacterial biofilms. Stable carbon and nitrogen isotope analyses were used to examine the specimens preserved in one stratigraphic horizon, modeled on the isotopic fractionation effect associated with modern predator-prey relationships. The Enspel data suggest the presence of several trophic levels, including primary producers (diatoms and higher plants), primary consumers (e.g., tadpoles and insects), and secondary consumers (e.g., the fish species *Paleorutilus enspelensis*). Terrestrial and aquatic plants were associated with the lowest $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values (mean plant = $-26.28\text{‰} \pm 0.45$, $3.18\text{‰} \pm 1.04$), primary consumers such as flies were one trophic level higher, and carnivores such as fish were yet another level higher. The $\delta^{15}\text{N}$ values for *P. enspelensis* also show enrichment in ^{15}N with increasing body length, implying a shift in diet or feeding strategy with size. *P. enspelensis* and tadpole (*Pelobates decheni*) samples showed intraorganism fractionation between 'muscle' and 'bone' tissues. A number of the features of the stable isotopic data are similar to those relationships seen in modern ecosystems and therefore suggest that stable isotope analyses can contribute to understanding ancient ecosystems.